Process-level Power Estimation in VM-based Systems

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PARA DIME

Research session 5: Virtualization, 23 April, 10:50 am.

Motivation

Problem

- Massive power consumption by data centers
- Hard to identify the largest power consumers
- Cannot attach a power meter to a VM
- Current approaches not fine-grained enough

Vision

- Process-level power estimation in VM-based systems
- Support for all CPU features
- Support for multi-tenant virtualization

Metrics

Hardware (HW) Performance Counters

- Representative and accurate metrics
- Mostly available on modern processors

Criteria selection

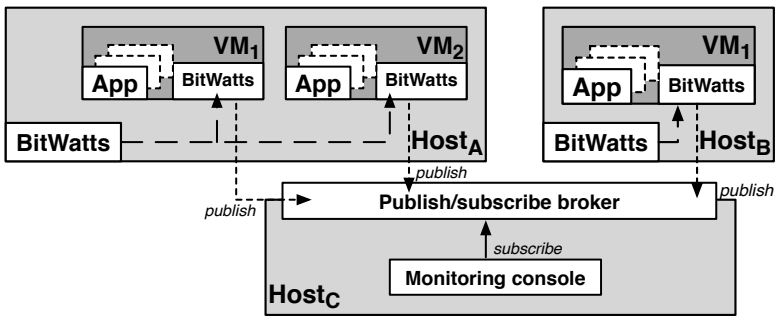
- Counter availability per CPU
- Monitoring overhead
- Best fit under several workloads

Selected HW Performance Counters

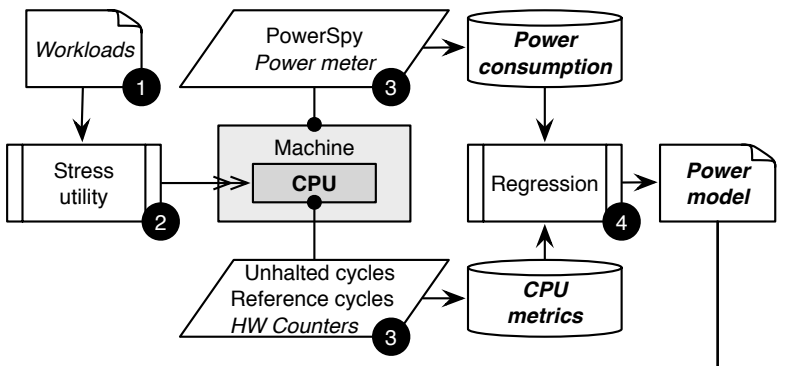
- CPU_CLK_UNHALTED:THREAD_P (*uc*)
- CPU_CLK_UNHALTED:REF_P

BitWatts

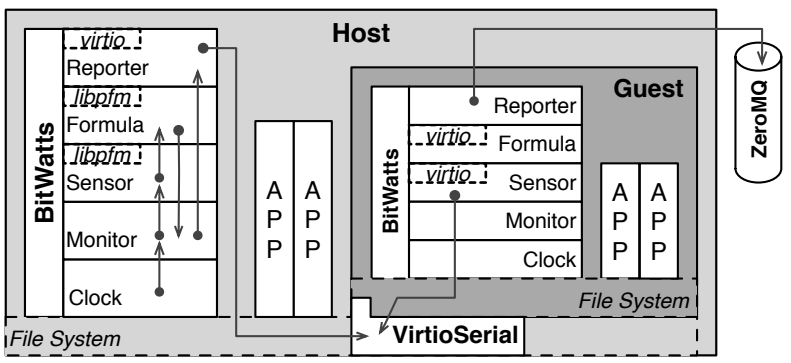
Architecture



Learn the CPU power model



Implementation

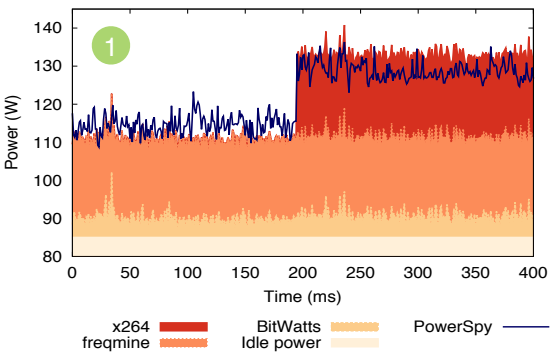


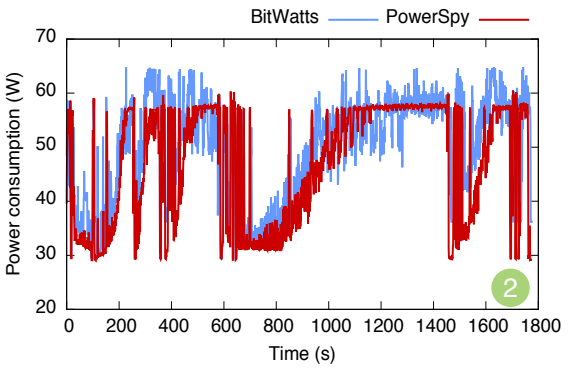
Power Model

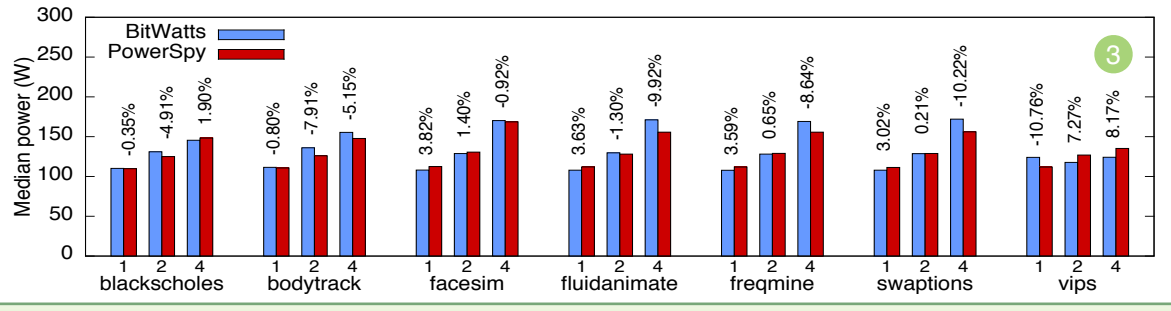
$$P_{host}(f) = P_{idle}(f) + \sum_{pid \in PIDs} P_{cpu}(f, uc^1_{pid} ... uc^N_{pid})$$

$$P_{cpu}(f, uc^1_{pid} ... uc^N_{pid}) = \sum_{n=1}^{N} P_f(uc^n_{pid})$$

Validation







1. Process-level power consumption of BitWatts, x264, and freqmine on a Xeon W3520 processor
2. Power consumption during the execution of SPECjbb on a i3 2120 with two threads
3. Power consumption of the host when scaling PARSEC on multiple VMs